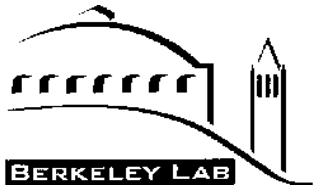

E.O. Lawrence Berkeley National Laboratory
Environment, Health, & Safety Division
Environmental Protection Group

United States Department of Energy

US Department of Energy

Radionuclide Air Emission Annual Report

(Subpart H of 40 CFR 61)
Calendar Year 1998

Site Name: **Ernest Orlando Lawrence Berkeley National Laboratory (LBNL)**

Operation Office Information

Office:	Oakland Operations Office		
Address:	1301 Clay St. Room 700 N Oakland, CA 94612		
Contact:	Steve Black	Phone:	(510) 637-1595

Site Information

Operator:	Ernest Orlando Lawrence Berkeley National Laboratory		
Address:	1 Cyclotron Road Berkeley, CA 94720		
Contractor Contact:	Henry H. Tran, C.H.P.	Phone:	(510) 486-7623
DOE Site Contact:	Carl Schwab	Phone:	(510) 486-4298

Section I. Facility Information

Site Description:

Laboratory Operations

The Ernest Orlando Lawrence Berkeley National Laboratory (Berkeley Lab) is a multi-program national laboratory managed by the University of California (UC) for the US Department of Energy (DOE). The Berkeley Lab's major role is to conduct basic and applied research in biology, physics, chemistry, materials, and energy. The Berkeley Lab, birthplace of the cyclotron, was founded by the late Nobel Laureate Ernest Orlando Lawrence in 1931.

Berkeley Lab operates facilities which contain Radioactive Material Areas (RMAs) or Radiological Storage Areas (RSAs) that are subject to the radioactive air emission regulations of the "National Emission Standard for Hazardous Airborne Pollutants other than Radon from DOE Facilities" (NESHAPs) or 40 CFR Part 61, Subpart H. Figure 1 illustrates the Berkeley Lab general site configuration and locations of facilities with RMAs or RSAs. Table 1 identifies the buildings illustrated in Figure 1. Figure 2 identifies other Berkeley Lab off site locations (Buildings 1, 3, 903, and 934) that potentially involve radioactive air emissions.

Radiochemical and radiobiological studies performed in many on site/off site laboratories at Berkeley Lab typically use millicurie quantities of a variety of radionuclides. (One millicurie is equal to 3.7×10^7 Becquerel (Bq).)

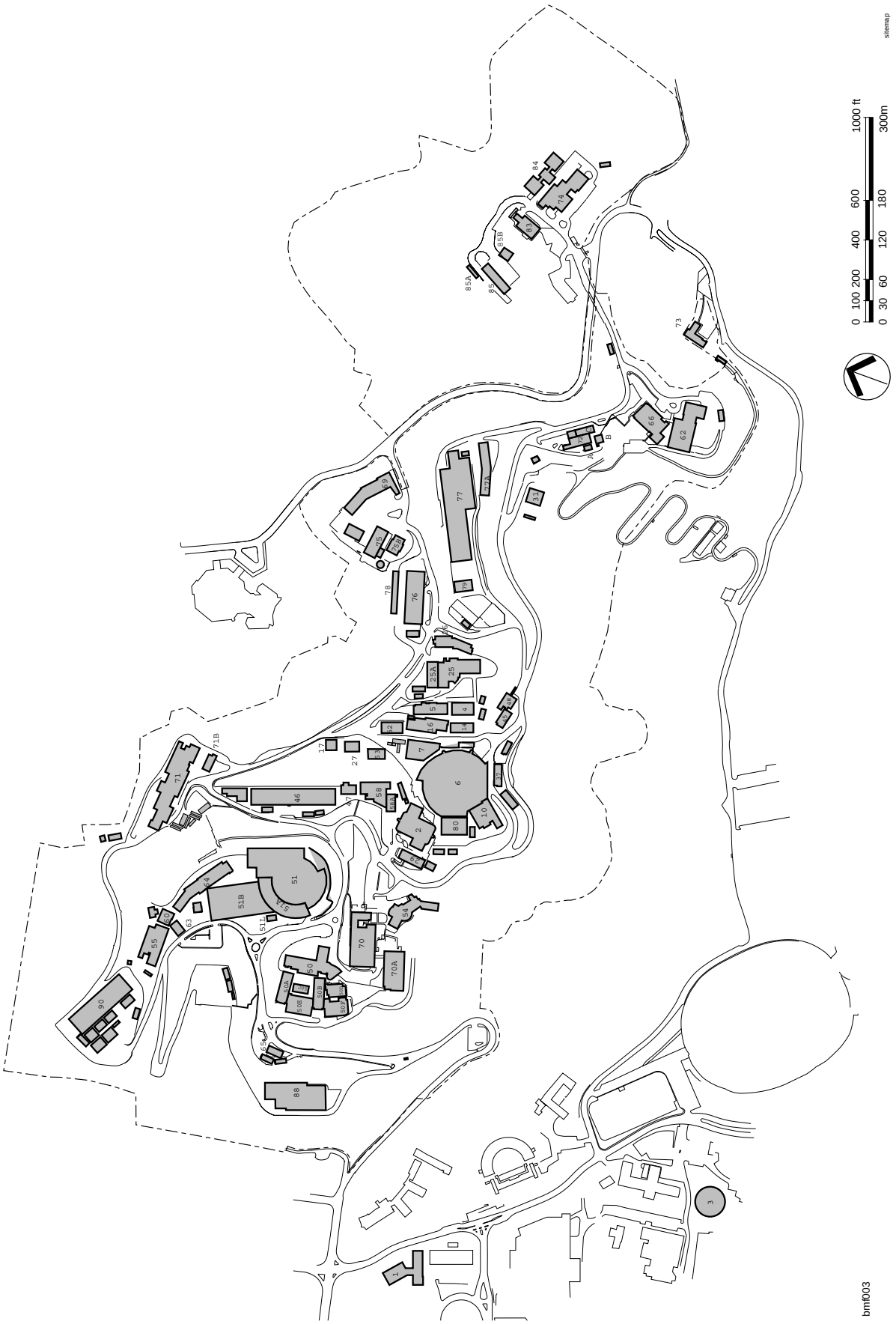

Figure 1. LBNL on Site Buildings

HILL-SITE BUILDINGS

2 Advanced Materials Laboratory (AML) & Center for X-ray Optics (CXRO)
4 Magnetic Fusion Energy (MFE)
5 Magnetic Fusion Energy (MFE)
6 Advanced Light Source (ALS)
7 Central Stores & Electronics Shops
10 Cell & Molecular Biology Research & Photography
14 Accelerator & Fusion Research & Earth Sciences
16 Magnetic Fusion Energy Laboratory
17 EH&S/Applied Sciences Lab
25 Mechanical Technology
25A Electronics Shops
26 Medical Services
27 High Voltage Test Facility & Cable Shop
29 Electronics Engineering, Research Medicine/Radiation Biophysics Offices
31 Chicken Creek Maintenance Bldg.
36 Grizzly Substation Switchgear Bldg.
37 Utilities Service
40 Electronics Development Lab
41 Magnetic Measurements Lab
42 Salvage
43 Compressor Bldg.
44 Indoor Air Pollution Studies
45 Fire Apparatus
46 RTSS, ALS, Accelerator Development
46A Real Time Systems Section (RTSS)
47 Advanced Accelerator Study
48 Fire Station
50 Physics, Accelerator & Fusion Research & Nuclear Science
50A Director's Office, Environment & Laboratory Development, Administration Division, Patents
50B Physics, Computer Center, IRD & ICSD
50C PID, Physics
50D MCSD & Nuclear Science
50E Earth Sciences
50F Computing Services, IRD
51 Bevalac/Bevatron (decommissioned)
51A Bevatron Experimental Area
51B External Particle Beam (EPB) Hall
52 Magnetic Fusion Energy Laboratory
53 SuperHILAC Development
54 Cafeteria
55 Research Medicine/Radiation Biophysics
55A Nuclear Magnetic Resonance (NMR)
56 Biomedical Isotope Facility
58 Accelerator Research & Development
58A Accelerator Research & Development Addition
60 High Bay Laboratory
61 Standby Propane Plant
62 Materials & Chemical Sciences
63 Accelerator & Fusion Research
64 Accelerator & Fusion Research
65 Data Processing Services
66 Surface Science & Catalysis Lab
68 Upper Pump House
69 Business Services, Materiel Management, Mail Room & Purchasing
70 Nuclear Science, Applied Science & Earth Sciences
70A Nuclear Science, Materials & Chemical Sciences & Earth Sciences
71 Heavy Ion Linear Accelerator (HILAC)
71A HILAC Rectifier
71B HILAC Annex
72 National Center for Electron Microscopy (NCEM)
72A High Voltage Electron Microscope (HVEM)
72B Atomic Resolution Microscope (ARM)
72C ARM Support Laboratory
73 Atmospheric Aerosol Research
74 Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory
75 Radioisotope Service & National Tritium Labeling Facility (NTLF)
75A Compactor, Processing & Storage Facility
76 Construction & Maintenance & Craft Shops
77 Mechanical Shops
77A Ultra High Vacuum Assembly Facility (UHV)
78 Craft Stores
79 Metal Stores
80 Electronics Engineering
80A Office Building
81 Liquid Gas Storage
82 Lower Pump House
83 Lab Cell Biology
84 Human Genome Laboratory
85 Hazardous Waste Handling Facility
88 88-Inch Cyclotron
90 Applied Science, Employment, Engineering, Occupational Health, Personnel, Protective Services

Off-Site Facilities

1 Donner Laboratory
3 Melvin Calvin Laboratory
903 Receiving
934 Life Sciences

Table 1. Key to LBNL Buildings Shown in Figure 1

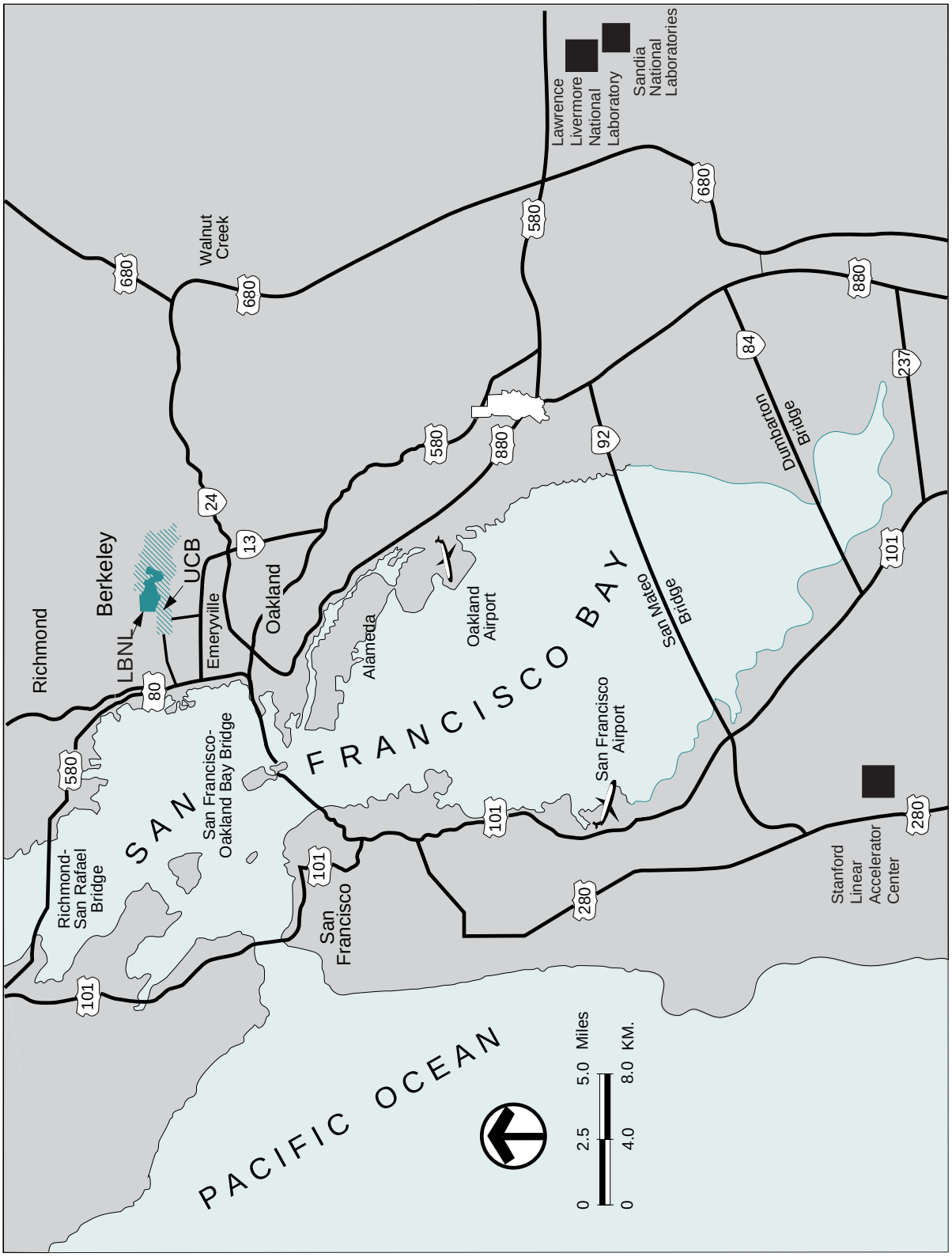

Figure 2. LBNL Off Site Research Locations & Vicinity Map

The Site

Berkeley Lab is situated upon a hillside above the main campus of the University of California at Berkeley (UCB). The 80-hectare (200-acre) site is located on the west and southwest-facing slope of the Berkeley Hills, at elevations ranging from 150 to 300 meters (500 to 1,000 feet) above sea level within the Cities of Berkeley and Oakland. It is located about five kilometers (three miles) east of San Francisco Bay and about 25 kilometers (fifteen miles) east of the City of San Francisco (Figure 3).

Berkeley Lab is located in an urban environment on land owned by the UC. On all sides of the Laboratory is a buffer zone of UC-owned land. In addition, the Laboratory maintains a landscape buffer zone between its facilities and the site boundary. Beyond the northern sides of the buffer zone there are predominantly single-family homes and beyond the west side are multiunit dwellings, student residence halls, and commercial districts. The area to the east and south, which is part of the University lands, is maintained in a largely natural state and includes recreational facilities and the University Botanical Garden. Although the population within 80 km (50 miles) of LBNL increased by about 20% during the 1970s and 1980s from 5 to 6 million, the populations of Berkeley and Oakland, the two cities immediately adjacent to LBNL, declined. Changes in population statistics from the 1990 census have not produced significant differences in dose.

The Laboratory's activities are conducted on site and off site. Berkeley Lab activities take place in structures totaling 186,000 gross square meters (gsm), or 2,000,000 gross square feet (gsf). The buildings are on the Berkeley Lab hillside site, plus additional facilities located on the University campus, notably the Donner Laboratory of Biology and Medicine (Building 1) and the Melvin Calvin Laboratory (Building 3). The main site space consists of 157,000 gsm in 190 permanent buildings and trailers. Off site space consists of 11,000 gsm in various University buildings on the UC at Berkeley (UCB) campus and 18,000 gsm in leased facilities in Emeryville and Berkeley.

Almost 3,000 scientists and support personnel work at Berkeley Labs main site. In addition, Berkeley Lab typically hosts 1,900 guests who worked at the site for varying lengths of time

The Climate

The climate of the Berkeley Lab site is greatly influenced by its close proximity to the Pacific Ocean and its exposure to the maritime air that flows in from San Francisco Bay. Seasonal temperature variations are small, with an approximate mean temperature difference between the summer [17^{o}C (63^{o}F)] and winter [9^{o}C (48^{o}F)] of only 8.5^{o}C (15^{o}F). The site proximity to San Francisco Bay and the Pacific Ocean keeps the humidity relatively high. The average annual rainfall is about 68 cm (27 inches). About 95% of the rainfall occur from October through April, and intensities are seldom greater than 1.3 cm/hr (0.5 in/hr). Thunderstorms, hail and snow are extremely rare. Winds are usually light, but summer sea breezes can reach up to 9-13m/s (20-30 mph). Winds from winter storms can reach speeds of 13 to 18 m/s (30 – 40 mph). The predominant wind directions are westerly and northwesterly during fair weather and southeasterly in advance of storms.

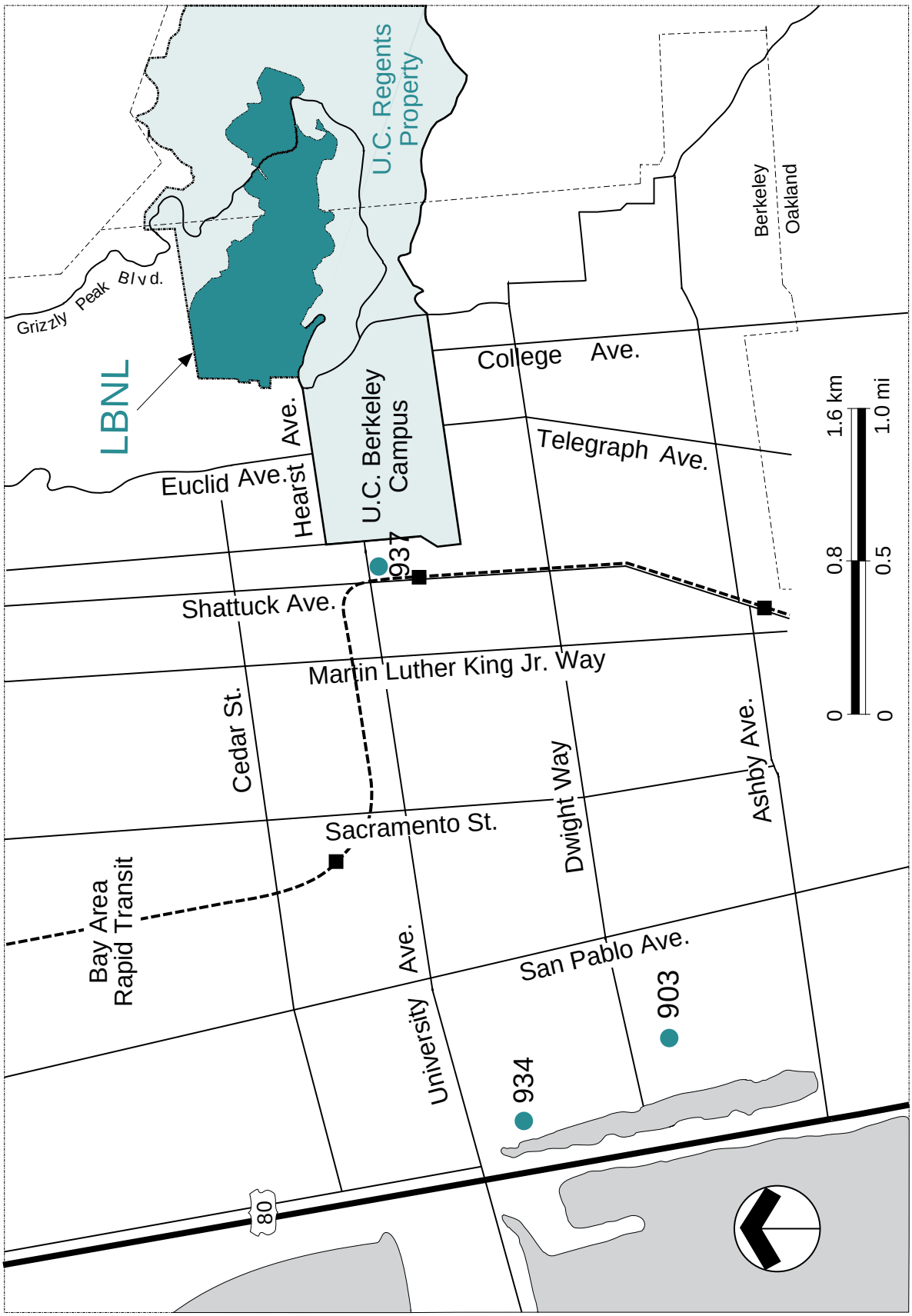

Figure 3. San Francisco Bay Area Map

Compliance Status of Lawrence Berkeley National Laboratory:

Berkeley Lab has been in full compliance with the requirements set forth in 40 CFR Part 61, Subpart H since 1995. Prior to reaching full compliance, a Federal Facilities Compliance Agreement (FFCA) with Region IX EPA was in force since August 1993. The US/EPA sent DOE written confirmation in November 1995 that Berkeley Lab had satisfactorily completed all requirements of the FFCA.

As a part of the FFCA, Berkeley Lab formalized all phases of its NESHAPs program and proposed a graded strategy for performing the "periodic confirmatory monitoring" called for in Section 61.93 (b)(4)(i) of the 40 CFR 61. Monitoring requirements are determined by dose modeling results that do not take credit for emission controls in place. Table 2 summarizes the US/EPA approved NESHAPs compliance strategy for stack monitoring which Berkeley Lab has followed since the beginning of 1995.

Table 2. Summary of NESHAPs Compliance Strategy for Monitoring Emissions in 1998

EDE Criteria [mrem/year]	Category	Monitoring Requirements	Number of Potential Release Points
EDE $\geq$ 10.0	Non-compliant	Reduce or relocate source term and re-evaluate prior to authorization.	0
10.0 > EDE $\geq$ 1.0×10^{-1}	**I**	• Continuous sampling or monitoring required • Telemetry for nuclides with half-lives < 100 hours • EPA Application to Construct or Modify required.	1
1.0×10^{-1} > EDE $\geq$ 5.0×10^{-2}	**II**	Continuous sampling with weekly analysis.	9
5×10^{-2} > EDE $\geq$ 1.0×10^{-2}	**III**	Continuous sampling with monthly analysis.	14
1.0×10^{-2} > EDE $\geq$ 1.0×10^{-3}	**IV**	Sampled annually during project activity.	0
EDE < 1.0×10^{-3}	**V**	Inventory controlled by Radiological Work Authorization/Permit (RWA/RWP) and periodic evaluation. No monitoring required	92

Source Description:

Berkeley Lab uses a wide variety of radionuclides in its radiochemical and biomedical research programs. In addition, radioactive materials are inevitably produced by the operations of the charged particle accelerators. Table 3 summarizes the radionuclides potentially used/monitored at Berkeley Lab during 1998.

Table 3. Radionuclides Potentially Used/Monitored at Berkeley Lab During 1998

Nuclide Name (Atomic Number)	Symbol	Principal Radiation Types	Energy (MeV)	Half-Life
Americium (95)	^{241}Am	alpha gamma	5.40 0.06	432 years
Argon (18)	^{41}Ar	beta gamma	1.2 1.3	1.83 hours
Californium (98)	^{250}C	alpha gamma	6.03 0.043	13.1 years
Carbon (6)	^{11}C^{14}C	positron/gamma beta	0.511 0.156	20.5 minutes 5730 years
Cesium (55)	^{137}Cs	beta gamma	0.514 0.043	30.2 years
Cobalt (27)	^{60}Co	beta gamma	0.318 1.33	5.27 years
Copper (29)	^{64}Cu ^{67}Cu	beta positron beta gamma	0.578 0.650 0.577 0.184	12.70 hours 61.9 hours
Curium (96)	^{248}Cm	alpha	5.08	3.39 x 10^5 years
Fluorine (9)	^{18}F	positron/gamma	0.511	109.7 minutes
Gallium (31)	^{68}Ga	beta	0.739	68.1 minutes
Germanium (32)	^{68}Ge	E.C.	0.005	288 days
Holmium (67)	^{166M}Ho	beta	1.855	1,200 years
Hydrogen /Tritium (1)	^{3}H	beta	0.0186	12.28 years
Indium (49)	^{111}In ^{114M}In	E.C./gamma I.T./E.C./gamma	0.170 0.190	2.81 days 49.51 days
Iodine (53)	^{123}I ^{125}I ^{131}I	E.C./gamma gamma beta gamma	0.159 0.027 0.606 0.159	13.1 days 60.14 days 8.04 days
Iron (26)	^{55}Fe ^{59}Fe	E.C./gamma beta gamma	 0.475 1.100	2.73 years 44.51 days
Manganese (25)	^{54}Mn	E.C./gamma	0.834	312 days
Nickel (28)	^{63}Ni	beta	0.066	100.1 years

Table 3 (Cont.). Radionuclides Potentially Used/Monitored at Berkeley Lab during 1998

Nitrogen (7)	^{13}N	positron/gamma	0.511	9.97 minutes
Oxygen (8)	^{15}O	positron/gamma	0.511	122 seconds
Phosphorus (15)	^{32}P ^{33}P	beta beta	1.71 0.249	14.3 days 25.3 days
Plutonium (94)	^{239}Pu ^{242}Pu	alpha alpha	5.155 4.901	2.411×10^4 years 3.76×10^5 years
Radium (88)	^{226}Ra	alpha gamma	4.784 0.186	1.60×10^3 years
Rubidium (37)	^{86}Rb	beta gamma	1.77 1.08	18.66 days
Selenium (34)	^{75}Se	E.C./gamma	0.265	118.5 days
Sodium (11)	^{22}Na	positron gamma	0.545 1.27	2.605 years
Strontium (38)	^{90}Sr	beta	0.546	28.6 years
Sulfur (16)	^{35}S	beta	0.167	87.44 days
Thorium (90)	^{232}Th	alpha beta	4.01 0.04	1.4×10^{10} years
Thallium (201)	^{201}Tl	E.C./gamma	0.167	3.05 days
Uranium (92)	^{233}U ^{238}U	alpha alpha beta	4.825 4.2 0.029	1.59×10^5 years4.47×10^9 years
Xenon (54)	^{122}Xe	E.C./gamma	0.350	20.0 hours
Zinc (30)	^{62}Zn ^{65}Zn	positron gamma	0.661.12	9.26 hours 244 days
Zirconium (40)	^{95}Zr	beta gamma	0.4 0.757	64 days

Of these radionuclides, the most commonly and widely used radionuclides in the research program are: H-3, C-14, F-18, P-32, S-35, and I-125. Radioactive gases produced by the accelerator operations are mainly short-lived radionuclides such as C-11, N-13, O-15, and Ar-41. These induced radioactive gases are normally produced in areas where the beam strikes beamline components.

During 1998, 21 laboratory buildings at Berkeley Lab had areas with the potential to emit radionuclides into the atmosphere. These areas are called Radioactive Material Areas (RMAs) or Radiological Storage Areas (RSAs) at Berkeley Lab. Based on historical operations and monitoring data, one source release point was identified for 1998 that was potentially within Category I; Building 75. All other Berkeley Lab's sources that were operational during 1998 are "small sources." That is, the effective dose equivalent (EDE) from each source is much less than 0.1 mrem/yr (1.0E-3 mSv/yr), the NESHAPs threshold limit for continuous real-time monitoring. Table 4 is a list of RMAs and RSAs at Berkeley Lab and NESHAPs sources by category derived from the Radiation Protection Program database.

Table 4. Potential NESHAPs Sources by Category

	NESHAPs Compliance Strategy Category					
Buildings with Radioactive Material Areas (RMAs)	**Category I**	**Category II**	**Category III**	**Category IV**	**Category V**	**TOTAL**
1	0	0	3	0	10	13
2	0	0	0	0	0	0
3	0	0	0	0	3	3
6	0	0	0	0	1	1
26	0	0	0	0	3	3
55	0	0	1	0	7	8
56	0	2	0	0	0	2
70	0	1	4	0	4	9
70A	0	0	5	0	12	17
71	0	0	0	0	6	6
72	0	0	0	0	2	2
74	0	0	0	0	11	11
75	1	2	0	0	2	5
75A	0	0	0	0	2	2
75C	0	0	0	0	1	1
76	0	0	0	0	1	1
83	0	0	0	0	8	8
85	0	2	0	0	0	2
88	0	2	1	0	3	6
903	0	0	0	0	1	1
934	0	0	0	0	15	15
TOTAL:	**1**	**9**	**14**	**0**	**92**	**116**

During 1998, air discharge points with the most significant potential for a routine or an accidental release were continuously monitored (sampled and analyzed) or periodically sampled and analyzed. Many very small sources, that is, sources with potential for routine annual off site EDE impacts of less than 1.0E-3 mrem (1.0E-5 mSv) are, in general, not sampled/monitored (category V sources). Instead of sampling or monitoring these category V sources, Berkeley Lab evaluates the potential impact of these sources with engineering calculations based on the annual usage quantities. The total number of category V sources reported this year is based on the number of RMAs and RSAs in the database maintained by Radiation Protection Group. All the potential RMAs and RSAs locations, rather than physical stacks, are counted in this category, regardless of whether there were any usage/storage of radioactive material within these locations.

Many Berkeley Lab release points qualify as "grouped sources" as described in the NESHAPs DOE guidance for the preparation of this document. The following grouping criteria were used:

- The sum of the EDEs attributable to all stacks in the group must be below 0.1 mrem (10^{-3} mSv).
- Sources must be in close proximity (same or nearby building), with similar operations and similar nuclides are used in the facilities.
- Sources grouped in the description section may not be grouped in the dose assessment section if the critical receptors are not the same.

Using this grouping scheme, Berkeley Lab created 15 NESHAPs sources (Table 5). For each source, Berkeley Lab used the EPA-approved atmospheric dispersion dose calculation computer code CAP88-PC to estimate the Effective Dose Equivalent (EDE) to an offsite maximally exposed individual (MEI). The fifteen CAP88-PC computer model assessments were separately performed to simulate nine point sources and six grouped sources for dose assessment during 1998. The remainder of this section will discuss the results of these assessments.

As identified in Figure 2, Buildings 1, 3, 903, and 934 are located outside of Berkeley Lab's main perimeter and should technically be labeled as separate "facilities" since they are not on one "contiguous site." However, Building 1 and Building 3 are located on the adjacent UC-Berkeley campus and are within walking distance from the main Berkeley Lab site. Buildings 903 and 934 are about five kilometers west of the main site. Annual radioactive air emissions from these offsite buildings and associated EDE at each local receptor is several orders of magnitude lower than the highest emissions and doses from the main Berkeley Lab site. Thus, it would be inappropriate and misleading to model and report these much lower EDEs separately. Therefore, for reporting and dose modeling purposes, all of these offsite buildings will be considered as being on one contiguous Berkeley Lab site.

Table 5. Berkeley Lab NESHAPs Point and Grouped Sources During 1998

NESHAPs Sources (point and group)	Location
Building 1	UC Berkeley Campus
Building 2 and 6	Main Site
Building 3	UC Berkeley Campus
Building 26 and 76	Main Site
Building 55 and 56	Main Site
Building 70 and 70A	Main Site
Building 71 and 72	Main Site
Building 74 and 83	Main Site
Building 75	Main Site
Building 75A	Main Site
Building 75C	Main Site
Building 85	Main Site
Building 88	Main Site
Building 903	West Berkeley
Building 934	West Berkeley

1. Building 1 (Donner Laboratory): Donner Laboratory conducts research in nuclear medicine through the use of new chemical probes and new instrumentation for applications to aging, atherosclerosis, and cancer. The building is located at the eastern edge of the University of California at Berkeley campus. The predominant nuclides used are H-3, C-14, P-32, S-35, and I-125 as labeled amino acids and DNA precursors. Many non-LBNL employees (i.e., UC) also share this building for various other research activities. Work is mostly done on bench tops and in hoods. Releases are from building vents and hoods. Many of these release points are classified as Category V. Three stacks in Building 1 are sampled and analyzed monthly for I-125, C-14, gross alpha, gross beta, and tritium. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 6.

Table 6. Building 1 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
9	10	ESE	UC Berkeley	C-14	1.50E-04	1.25E-05	1.04%
				H-3	4.80E-04	1.66E-06	0.14%
				I-125	9.40E-05	1.19E-03	98.82%
				P-32	3.50E-07	7.51E-08	0.01%
					TOTAL:	**1.20E-03**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

2. Buildings 2 and 6 (Center for Advanced Material Laboratory, Center for X-Ray Optics and Advanced Light Source): The Center for Advanced Material does fundamental

research in areas of materials science that US Industry and DOE Technology Offices have identified as critical to their missions and objectives. In this way it provides a basic research underpinning for more applied and development work in industrial, government, and academic laboratories. The Center for X-ray Optics addresses national needs in the technical areas of efficient and high precision transport, focusing and spectroscopic analysis of electromagnetic radiation in the soft x-ray and extreme ultraviolet (EUV) regions of the spectrum. Progress in the physical, chemical, and life sciences is enhanced by the broad availability of these new resources.

The Advanced Light Source (ALS) is the world's brightest synchrotron radiation source in the extreme ultraviolet and soft x-ray regions of the spectrum. The ALS is a national facility open to qualified scientists and engineers in a broad range of disciplines. The ALS injector produces stray neutrons during its operation, which activate the air in the injector vault. Since the ALS is a low power accelerator, compared to LBNL's other accelerators, its inventory of air activation products is substantially lower than the 88-inch Cyclotron. The maximum potential annual releases of N-13 and O-15 (the important air activation products of the ALS) are computed to be 0.084 Ci (3 x 10^9 Bq) and 0.006 Ci (2 x 10^8 Bq), respectively.

Buildings 2 and 6 are classified as Category V release points and the radiological inventory is controlled by Radiological Work Authorization/Permit (RWA/RWP) and periodic evaluation. No monitoring is required. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 7.

Table 7. Building 2/6 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
20	370	NE	UC Lawrence Hall of Science	N-13	8.40E-02	2.40E-05	95.83%
				O-15	6.00E-03	1.04E-06	4.17%
				U-238	1.00E-11	5.84E-10	0.00%
					TOTAL:	**2.50E-05**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

3. Building 3 (Calvin Laboratory): The Calvin Laboratory conducts basic research on the dynamics of living cells and on the interaction of radiant energy with organic matter. The Laboratory has made significant contributions to our understanding of the molecular mechanisms of photosynthesis and of the effects of environmental pollutants on plant and animal cells. Cell and molecular biology studies are performed in this laboratory. As with Building 1, this building is located in the eastern portion of the University of California at Berkeley campus. The predominant radionuclides used are H-3, P-32, S-35, and C-14 as labeled amino acids and DNA precursors. $^{14}CO_2$ is also used in this laboratory as an "incubant." Building 3 is wholly occupied by Berkeley Lab personnel. Work is done on bench tops and in hoods. Releases are from building vents and hoods. Building 3 is classified as a Category V release point and the radiological inventory is controlled by Radiological Work Authorization/Permit (RWA/RWP) and periodic evaluation. No

monitoring is required. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 8.

Table 8. Building 3 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
15	60	S	Res. & Business	P-32	3.80E-08	3.10E-09	99.89%
				C-14	1.00E-10	3.36E-12	0.11%
					TOTAL:	**3.10E-09**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

4. Building 26 and 76 (Medical Services and Bioassay, Radiation and Analytical Measurements Laboratory): Low-level radiochemical analyses of bioassay and environmental samples and hazardous waste are performed by Berkeley Lab's Radiation and Analytical Measurements Laboratory (RAML). In addition**,** Building 76 has some counter calibration sources. RAML is the only radionuclide user in these buildings. Only trace quantities of radionuclides are used in sample spiking and standards preparation. The Building 26/76 grouping is classified as a Category V release point and the radiological inventory is controlled by Radiological Work Authorization/Permit (RWA/RWP) and periodic evaluation. No monitoring is required. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 9.

Table 9. Building 26/76 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
8	240	N	UC Lawrence Hall of Science	I-125	3.00E-09	4.54E-08	73.15%
				I-131	3.00E-09	1.66E-08	26.84%
				C-14	5.00E-11	4.92E-12	0.01%
					TOTAL:	**6.20E-08**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

5. Buildings 55 and 56 (Research Medicine & Radiation Biophysics, Biomedical Isotope Facility): The Research Medicine & Radiation Biophysics and Biomedical Isotope Facility develops radiopharmaceuticals and advanced medical imaging technologies including positron emission tomography (PET), single photon emission computed tomography (SPECT), and nuclear magnetic resonance imaging (MRI) and applies them to the study of atherosclerosis, heart disease, aging, neurological and psychiatric diseases, and cancer. The primary radiological activities carried out in Building 55 are PET using F-18, and metabolic studies using I-125. The radiological activities take place in 2 laboratories and a PET camera room. Operations with radioiodine are done in a HEPA and Tetraethylene Diamine (TEDA)-doped carbon-filtered enclosures. One stack in Building 55 is sampled and analyzed monthly

for I-125, gross alpha, and gross beta. Building 56 houses a small accelerator to produce F-18 for PET and other experimental studies. Airborne emissions from Building 56 are limited to positron emitters from air activation and F-18 production. Two locations in Building 56 are continuously monitored (real-time) for positron emitters. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 10.

Table 10. Building 55/56 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
9	170	N	Residence	C-14	2.50E-09	1.43E-10	0.00%
				H-3	1.30E-08	2.88E-11	0.00%
				I-125	2.80E-04	2.45E-03	45.44%
				F-18	3.50E-01	2.95E-03	54.56%
				CR-51	1.00E-08	2.10E-10	0.00%
				RU-103	5.00E-09	2.31E-09	0.00%
				SN-113	1.00E-08	2.83E-09	0.00%
				TC-99M	5.70E-07	1.03E-09	0.00%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		**TOTAL:**	**5.40E-03**	**100.00%**

6. Buildings 70 & 70A (Nuclear, Materials, Chemicals, Earth Sciences, and Life Sciences): The Nuclear Science programs include nuclear structure and reactions, relativistic nuclear collisions, nuclear & particle astrophysics, nuclear data evaluation, and nuclear theory. The Materials Sciences Division performs research in the discovery, creation, characterization, and development of new materials and materials phenomena. The Chemical Sciences Program conducts research in the areas of chemical physics and the dynamics of chemical reactions, the structure and reactivity of transient species, electron spectroscopy, surface chemistry and catalysis, electrochemistry, chemistry of the actinide elements and their relationship to environmental issues, and atomic physics. The Earth Sciences programs perform fundamental and applied research related to energy and environmental resources. Programs carried out in these facilities include super-heavy nuclear studies, waste migration studies (tracer amounts), and nuclear chemical studies. There are also two biological science groups in 70A. Research activities using radioactive material are carried out by various research groups in 26 of the many small laboratories within the two buildings. Sixteen sources in Building 70 and 70A are classified as a Category V release points and the remaining 10 locations are sampled continuously and analyzed periodically; one is analyzed weekly, and nine are analyzed monthly. Monitoring analytes include I-125, C-14, gross alpha, gross beta and tritium. In calculating the dose, it is more conservative to assume that gross alpha and gross beta radionuclides are Thorium 232 (Th-232) and Strontium 90 (Sr-90), respectively. A summary of the CAP88-PC source term input parameters and EDE results for these release points is presented in Table 11.

Table 11. Buildings 70&70A Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
13	330	W	UCB Dormitory	C-14	1.40E-05	1.44E-07	0.05%
				H-3	6.20E-04	2.42E-07	0.09%
				I-125	5.50E-08	8.57E-08	0.03%
				Gross Beta as Sr-90	8.00E-06	1.30E-05	4.80%
				Gross Alpha as Th-232	4.20E-07	2.57E-04	95.03%
					TOTAL:	**2.70E-04**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

7. Buildings 71 and 72 (Heavy Ion Accelerator, National Center for Electron Microscopy (NCEM)) The Heavy Ion Accelerator is no longer in operation. The NCEM provides the electron microscopy community with advanced instrumentation for electron-optical characterization of materials. With the highest resolution (1.6Å) electron microscope in the US and the highest-energy microscope, NCEM is a national facility open to qualified researchers in materials science and associated disciplines. The Building 71/72 grouping is classified as a Category V release point and the radiological inventory is controlled by Radiological Work Authorization/Permit (RWA/RWP) and periodic evaluation. No monitoring is required. A summary of the CAP88-PC source term input parameters and EDE results for these release points is presented in Table 12.

Table 12. Buildings 71/72 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
13	220	E	UC Lawrence Hall of Science	None	0	0	0
					TOTAL:	**0**	**0**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

8. Buildings 74 and 83 (Research Medicine, Cell Biology): These buildings include a wide variety of cell biology, virology, research medicine, and human genome projects. The Human Genome Center (HGC) of the Lawrence Berkeley National Laboratory is oriented almost exclusively towards developing and implementing directed methodologies for cost-effective and accurate high throughput human DNA sequencing. Releases from 74 come from hoods and stacks that vent individual workplaces. Building 83 vents are through HEPA-filtered biological cabinets. Research activities involving I-125 are normally carried out in TEDA-doped activated-carbon-filtered enclosures. The building 74/83 grouping is classified as a Category V release point and the radiological inventory is controlled by Radiological

Work Authorization/Permit (RWA/RWP) and periodic evaluation. No monitoring is required or performed. A summary of the CAP88-PC source term input parameters and EDE results for these release points is presented in Table 13.

Table 13. Buildings 74/83 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
7	120	S	UC Berkeley	C-14	3.00E-09	2.36E-10	0.33%
				H-3	1.50E-08	5.47E-11	0.08%
				P-32	3.30E-07	6.14E-08	86.52%
				S-35	1.50E-07	5.06E-09	7.13%
				TC-99M	1.50E-06	4.22E-09	5.94%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		**TOTAL:**	**7.10E-08**	**100.00%**

9. Building 75 (National Tritium Labeling Facility): The National Tritium Labeling Facility (NTLF) is a designated Department of Energy (DOE) National User Facility engaged in tritium labeling research and development. It offers the US and international biomedical research community a fully equipped laboratory for the synthesis and analysis of tritium labeled compounds. The NTLF is mainly used for activities in which a wide variety of molecules are labeled with tritium and purified for further use in chemical, biochemical, and radiopharmaceutical studies. There are two stack release points for these activities; real time monitoring is performed continuously on one and continuous sampling with subsequent laboratory analysis is performed on both. The radionuclide releases are in the form of gaseous tritium (HT, T_2) and tritiated water (HTO, T_2O). Gaseous tritium releases are quantified as tritiated water even though their impacts are 1/25,000 of those of comparable releases of tritiated water resulting in a very conservative dose estimate. Tritium release at Berkeley Lab mainly comes from the stack located in the northern hillside near Building 75. This stack is the closest discharge point to the maximally exposed offsite individuals (MEI) which is the UC Lawrence Hall of Science, located 110 meters northwesterly. Other discharge points from the Building 75 roof are further from offsite individuals. Using a very conservative approach, it is assumed that all tritium emissions are released from the hillside stack. In addition, for many years, LBNL conservatively ignored the momentum effect (i.e., stack effluent exit velocity was set to zero) in the CAP88-PC computer model, which significantly over estimated the MEI dose. As recommended by US EPA, starting CY98, LBNL began to include the momentum effect in the CAP88-PC computer model to more closely reflect the actual physical conditions of the stack exhaust.

In 1990 the NTLF began a program to reduce both planned and unplanned releases of HTO. This program has resulted in a very notable decrease in stack emissions from a maximum of 570 Ci in 1988 to 41 Ci in 1997, and 115 Ci in 1998. Tritium emissions rose in 1998 from the previous year because of a combination of increased research activity at the NTLF and an unplanned release of 1.3×10^{12} Bq (35 Ci) on July 24, 1998 (see Section IV for further detail). Prior to the July incident, the NTLF did not have a significant unplanned release in more than four years.

Reviewing historical release records, there are two noticeable periods of tritium reductions: An initial steep reduction in 1990 and a second decline beginning in 1995. This second period is noteworthy because of the added difficulty in reducing tritium emissions appreciably from their present already low level. Several factors have contributed to the recent reduction of tritium emissions. Two significant engineering changes during 1995 included the addition of redundant valving on vacuum pumps close to the tritium source, and the replacement of the existing silica gel traps with broader traps that give the same flow, but give higher HTO trapping efficiency. Many other minor engineering changes and procedural revisions were implemented during 1995, and these all combined to markedly diminish HTO releases from the NTLF, especially since the later half of CY95.

The NTLF release point is the only source at Berkeley Lab that potentially/historically results in more than 1% of the NESHAPs EDE dose standard. For reporting purposes, the MEI of this release point is also identified as the MEI for the whole Berkeley Lab site during 1998. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 14.

Table 14. Building 75 (NTLF) Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
8.5	110	NW	UC Lawrence Hall of Science	H-3	115	2.70E-01	100.00%
					TOTAL:	**2.70E-01**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

10. Buildings 75A and 75-127 (Old Hazardous Waste Handing Facility): The Berkeley Lab's Hazardous Waste Handling Facility (HWHF) was previously located in Buildings 75A and part of Building 75 (room 127) before relocating to its present location at Building 85. Currently, all RMAs in this old facility, including a diffuse source of tritium, have been decontaminated and decommissioned. All radiological emissions reported here were associated with the facility closure project. There are two stack sampling system temporarily installed in this facility to monitor for tritium, gross alpha and gross beta.. In calculating the dose, it is more conservative to assume that gross alpha and gross beta radionuclides are Thorium 232 (Th-232) and Strontium 90 (Sr-90), respectively. A summary of the CAP88-PC source term input parameters and EDE results from Building 75A and 75-127 is presented in Table 15.

Table 15. Building 75A & 75-127 (Old HWHF) Release Point Characteristics (Point Source) and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
8	150	NW	UC Lawrence Hall of Science	H-3	8.10E-04	1.82E-06	0.87%
				Gross Beta as Sr-90	2.10E-07	1.70E-06	0.81%
				Gross Alpha as Th-232	5.60E-08	2.06E-04	98.33%
					TOTAL:	2.10E-04	100.00%

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

Notes: For many previous years, there was a tritium diffuse source located in Building 75A (old Hazardous Waste Handing Facility) resulting from stored tritium waste. Since all RMAs and RSAs in this facility have been decontaminated and decommissioned, there is no longer a diffuse source at LBNL.

11. Building 85 (New Hazardous Waste Handing Facility): The entire Berkeley Lab waste operations moved to the newly constructed HWHF (Building 85) in mid 1997. This building has two radiological stacks equipped with continuous air sampling system to monitor for gross alpha, gross beta, C-14, I-125, and tritium. In calculating the dose, it is more conservative to assume that gross alpha and gross beta radionuclides are Thorium 232 (Th-232) and Strontium 90 (Sr-90), respectively. A summary of the CAP88-PC source term input parameters and EDE results for this point source Building 85 is presented in Table 16.

Table 16. Building 85 (New HWHF) Release Point Characteristics (Point Source) and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
7	120	S	UC Berkeley	C-14	9.40E-04	4.15E-05	5.69%
				H-3	1.80E-01	3.49E-04	47.81%
				I-125	1.00E-06	7.02E-06	0.96%
				Gross Beta as Sr-90	3.30E-07	2.28E-06	0.31%
				Gross Alpha as Th-232	9.80E-08	3.30E-04	45.23%
					TOTAL:	**7.30E-04**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

12. Building 75C (Calibration Sources): Building 75C is a storage facility for calibration sources. Building 75C is classified as a Category V release point and the radiological

inventory is controlled by Radiological Work Authorization/Permit (RWA/RWP) and periodic evaluation. No monitoring is required. A summary of the CAP88-PC source term input parameters and EDE results for these release points is presented in Table 17.

Table 17. Building 75C Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
N/A	N/A	N/A	N/A	N/A	0	0	0
					TOTAL:	**0**	**0**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

13. Building 88 (88-inch Cyclotron): The Cyclotron accelerates beams from hydrogen to uranium in support of national programs in nuclear science, biology, medicine, and industrial applications. The primary airborne impact to an offsite individual from this facility is attributable to short-lived air activation radionuclides (mostly positron emitters) produced in the cyclotron vault during the fraction of the beam year when intense light ions are accelerated. Positron releases were measured directly using the real-time monitoring system and were significantly smaller than the theoretical values used in previous years. The quantity of activation products is controlled by the fraction of the beam year spent running light ions, and limits on circulating beam current. In addition to accelerator-produced positrons, small amounts of actinide radionuclides and other radioactive targets and radioisotopes are also used in experimental caves, fume hoods, and glove boxes. Releases are estimated based on isotope inventories/receipts and from two recently upgraded stack sampling systems. For conservatism in dose estimate, all positron emitters from this facility are assumed to be C-11, and gross alpha and gross beta radionuclides are Thorium 232 (Th-232) and Strontium 90 (Sr-90), respectively. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 18.

Table 18. Building 88 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
12	110	W	Residence	BA-133	1.00E-11	3.65E-11	0.00%
				HG-203	1.00E-11	7.53E-13	0.00%
				MN-54	1.00E-10	7.83E-11	0.00%
				C-11	6.40E-01	7.37E-04	89.91%
				Gross Beta as Sr-90	4.60E-07	8.32E-07	0.10%
				Gross Alpha as Th-232	1.30E-07	8.19E-05	9.99%
					TOTAL:	**8.20E-04**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

14. Building 903 (Receiving Warehouse): Building 903 is located off-site at 2700 Seventh Street in Berkeley. The 903 warehouse functions include central receiving, bulk storage,

bulk issue, and used furniture storage. Currently there are some induced radioactive components (i.e., accelerator shielding blocks or beam magnets) stored inside and outside the building. Building 903 is classified as a Category V release point and the radiological inventory is controlled by Radiological Work Authorization/Permit (RWA/RWP) and periodic evaluation. No monitoring is required. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 19.

Table 19. Building 903 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
N/A	N/A	N/A	N/A	N/A	0	0	0
					TOTAL:	**0**	**0**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

15. Building 934 (Molecular and Cell Biology): This building is located off site, roughly 5 kilometers (3 miles) from Berkeley Lab. The radiological activities include cell and molecular biology research. The research employs RNA and DNA precursors and amino acids labeled with H-3, C-14, P-32, and S-35. Metabolism of S-35 amino acids produces $^{35}SO_2$, which is released to the atmosphere. All release points in this building are classified as Category V release points. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 20.

Table 22. Building 934 Release Point Characteristics and Dose Impacts

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	LOCAL MEI EDE [mrem**/yr]	% Total EDE
4	38	N	Business	P-32	4.80E-07	3.66E-07	98.95%
				S-35	3.00E-08	3.87E-09	1.05%
					TOTAL:	**3.70E-07**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

Section II. Air Emissions Data

Point Source	# of Sources	Type Control	Efficiency [%]	Distance to Nearest Receptor
Building 1	13	None(3)	NA	10 m (School in the same Building)
Building 3	3	None(3)	NA	60 m (Workplace)
Building 75 (NTLF)	5	Silica Gel(5) HEPA	>99 >99	110 m (UC Lawrence Hall of Science)
Building 75A	2	TEDA-DAC HEPA(2)	> 75	150 m (UC Lawrence Hall of Science - LHS)
Building 75C	1	None	NA	150 m (UC Lawrence Hall of Science - LHS)
Building 85	2	HEPA TEDA-DAC	>99 >75	120 M (UC Berkeley)
Building 88 Vault	6	HEPA TEDA-DAC	>99 >75	110 m (Residence)
Building 903	2	None	NA	10 m (Business)
Building 934	15	None(3)	NA	38 m (Business)

Grouped Source	# of Sources	Type Control	Efficiency [%]	Distance to Nearest Receptor
Building 2/6	2	None	NA	370 m (UC Lawrence Hall of Science)
Buildings 26/76	4	HEPA	>99	240 m (UC Lawrence Hall of Science)
Building 55/56	11	HEPA TEDA-DAC(2)	>99 >75	170 m (Residence)

Buildings 70 & 70A(4)	26	HEPA (Manifolds) None (Hood)	>99 NA	330 m (UCB Dormitory)
Building 71/72	8	None	NA	220 m (UC Lawrence Hall of Science)
Buildings 74/74B/83	21	TEDA-DAC(2) None	>75 NA	120 m (UC Berkeley)

Non-Point Source	Radionuclide	Annual Quantity
None	None	None

Notes:

(1) The radionuclides released from the accelerators are air activation products, for which emission control is impractical.

(2) Tetraethylene Diamine (TEDA)-doped activated carbon traps.

(3) The uncontrolled releases are from Berkeley Lab fume hoods, which are unfiltered.

(4) The stacks included in this group source vent a number of laboratories whose research employs μCi and mCi (between 3.7×10^4 and 3.7×10^7 Bq) quantities of a number of actinides. The most conservative dose-equivalent representative of the actinides was used.

(5) Silica gel traps are >99% efficient traps for HTO as long as they are changed before breakthrough. NTLF personnel regularly change traps when working in the facility.

Quantities of nuclides released from Berkeley Lab stacks during 1998 are given in Table 21. These data are used to calculate the collective population dose for 1998.

Table 21. Total Radioactivity in Air Effluent Potentially Released During 1998

Nuclide	Total Air Effluent [Ci/yr]	[Bq/yr]	% Total Effluent
H-3	1.15E+02	4.26E+12	99.0698%
C-11	6.40E-01	2.37E+10	0.5505%
F-18	3.50E-01	1.30E+10	0.3010%
N-13	8.40E-02	3.11E+09	0.0722%
O-15	6.00E-03	2.22E+08	0.0052%
C-14	1.10E-03	4.08E+07	0.0009%
I-125	3.75E-04	1.39E+07	0.0003%
Gross Beta as SR-90	9.00E-06	3.33E+05	0.0000%
TC-99M	2.07E-06	7.66E+04	0.0000%
P-32	1.20E-06	4.43E+04	0.0000%
Gross Alpha as TH-232	7.04E-07	2.60E+04	0.0000%
S-35	1.80E-07	6.66E+03	0.0000%
CR-51	1.00E-08	3.70E+02	0.0000%
SN-113	1.00E-08	3.70E+02	0.0000%
RU-103	5.00E-09	1.85E+02	0.0000%
I-131	3.00E-09	1.11E+02	0.0000%
MN-54	1.00E-10	3.70E+00	0.0000%
BA-133	1.00E-11	3.70E-01	0.0000%
HG-203	1.00E-11	3.70E-01	0.0000%
U-238	1.00E-11	3.70E-01	0.0000%
TOTAL:	**1.16E+02**	**4.30E+12**	**100.0000%**

Section III. Dose Assessments

Description of Dose Model

To meet DOE guidance, the US/EPA atmospheric dispersion/radiation dose calculation computer code, CAP88-PC version 1.0, was used to calculate the Effective Dose Equivalent (EDE) to an individual within each population segment at various distances and from various release points. A total of fifteen CAP88-PC "individual" runs were executed to model 15 single/grouped release points as described in Section I. As mentioned previously, the NTLF (Building 75) was identified as the major release point at Berkeley Lab. Therefore, the Maximally Exposed Individual (MEI) associated with this facility was also specified (with appropriate distances and directions) in each of these fifteen individual CAP88-PC runs. The reported EDE to an MEI at Berkeley Lab includes contributions from all fifteen CAP88-PC models (see Table 22).

Collective population dose is calculated as the average radiation dose to an individual in a specified area, multiplied by the number of individuals in that area. One "population" CAP88-PC run was used to carry out this population dose assessment. This CAP88-PC model is based on the input parameters from the Building 75 computer run, with the source terms replaced by all the radionuclides listed in Table 23. A summary of this collective dose assessment attributed to each radionuclide is given in Table 23**.**

Summary of Input Parameters

The 1998 radioactive air emissions were either measured or conservatively derived based on the inventory received during the year and are shown in Table 21 in Section II.

Berkeley Lab used onsite meteorological data for performing dose assessments. Berkeley Lab began collecting this data in early 1994. These data more accurately reflect the local wind directions and atmospheric stability categories in the EPA computer model than the previously used Oakland Airport data. The meteorological data input to the CAP88-PC for the current assessment are based on the meteorological data collected during 1998 from the weather tower at the Berkeley Lab.

Table 22. Summaries of Dose Assessment from All Berkeley Lab Release Points

		Relative to the Specified Building					Relative to the MEI of Building 75			
Building Number	Building Name	Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Local MEI Dose [mrem*/yr]	BLD-75 Distance [meter]	BLD-75 MEI Dir.	BLD-75 MEI Dose [mrem*/yr]	% Total EDE
BLD-1	Donner Laboratory @UCB	9	10	ESE	UC Berkeley	1.20E-03	980	ENE	1.20E-03	0.432%
BLD-2/6	Advanced Material Lab/ALS	20	370	NE	UC Lawrence Hall of Science	2.50E-05	370	NE	2.50E-05	0.009%
BLD-3	Calvin Lab @UCB	15	60	S	Res. & Business	3.10E-09	1070	NE	2.90E-09	0.000%
BLD-26/76	RAML/Counting Lab.	8	240	N	UC Lawrence Hall of Science	6.20E-08	240	N	6.20E-08	0.000%
BLD-55/56	Research Medicine/BIF	9	170	N	Residence	5.40E-03	490	E	5.00E-03	1.800%
BLD-70/70A	Nuclear / Life Sciences	13	330	W	Dormitory	2.70E-04	510	NE	1.90E-04	0.068%
BLD-71/72	HILAC/NCEM	13	220	E	UC Lawrence Hall of Science	0.00E+00	220	E	0.00E+00	0.000%
BLD-74/83	Buildings 74/83 Research Med.	7	120	S	UC Berkeley	7.10E-08	730	WNW	7.20E-08	0.000%
BLD-75	National Tritium Labeling Facility	8.5	110	NW	UC Lawrence Hall of Science	2.70E-01	110	NW	2.70E-01	97.176%
BLD-75A/75-127	Old Hazardous Waste Handling Facility (HWHF)	8	150	NW	UC Lawrence Hall of Science	2.10E-04	150	NW	2.10E-04	0.076%
BLD-75C	EHS Calibration Sources	N/A	150	NW	UC Lawrence Hall of Science	0.00E+00	150	NW	0.00E+00	0.000%
BLD-85	New Hazardous Waste Handling Facility (HWHF	7	120	S	UC Berkeley	7.30E-04	550	WNW	8.60E-04	0.310%
BLD-88	88-Inch Cyclotron	12	110	W	Residence	8.20E-04	670	ENE	3.60E-04	0.130%
BLD-903	Receiving Warehouse	N/A	N/A	N/A	N/A	0.00E+00	N/A	N/A	0.00E+00	0.000%
BLD-934	Molecular & Cell Bio. (off site)	4	38	N	Business	3.70E-07	4900	ENE	1.80E-07	0.000%

(*) 1 mrem = 1.0E-2 mSv

TOTAL :	**2.78E-01**	**100.000%**

Table 23. Summary of Collective (Population within 80 km of Berkeley Lab) EDE Assessment

Nuclide	Collective EDE [Person-rem* /yr]	% Total Collective EDE
H-3	2.47E+00	98.17%
Gross Alpha as TH-232	1.78E-02	0.71%
F-18	1.39E-02	0.55%
C-11	1.12E-02	0.45%
I-125	1.41E-03	0.06%
N-13	9.46E-04	0.04%
C-14	4.22E-04	0.02%
Gross Beta as SR-90	3.53E-04	0.01%
O-15	1.92E-05	0.00%
P-32	8.33E-07	0.00%
U-238	8.22E-08	0.00%
TC-99M	2.25E-08	0.00%
S-35	1.89E-08	0.00%
RU-103	1.65E-08	0.00%
SN-113	1.39E-08	0.00%
I-131	8.28E-09	0.00%
MN-54	3.44E-09	0.00%
BA-133	1.61E-09	0.00%
CR-51	1.51E-09	0.00%
HG-203	2.27E-11	0.00%
Total:	**2.52E+00**	**100.00%**

(*) 1 Person-rem = 1.0E-2 Person-Sv

Compliance Assessment

This compliance assessment uses the computer code CAP88-PC Version 1.0 to calculate the Effective Dose Equivalent (EDE) to an off site Maximally Exposed Individual (MEI). This exposure represents the sum of impacts from all fifteen release points modeled to that location (the MEI of Building 75). The CY98 MEI dose increased by about a factor of two compared to the CY97 MEI dose due to a combination of increased research activity at the NTLF and an unplanned release of 1.3×10^{12} Bq (35 Ci) on July 24, 1998 (see Section IV for further detail). Summaries of the dose assessment from each release point are presented in Table 22.

Effective Dose Equivalent: 0.28 mrem/year (2.8E-3 mSv/year)

Location of Maximally Exposed Individual: UC Lawrence Hall of Science at 110 meters Northwest of Building 75

Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. (See, 18 U. S. C. 1001).

Signature:_____Date:_____

David C. McGraw
Division Director, Environment, Health and Safety

Signature:_____Date:_____

Richard H. Nolan
Director, DOE Berkeley Site Office

Section IV. Additional Information

Additions or Modifications

Building 75A and part of Building 75 (Old Hazardous Waste Handling Facility): Currently, all RMAs in this old facility have been decontaminated and decommissioned.

Unplanned Releases

On July 24, 1998, an unplanned tritium emission of 35 curies took place at the National Tritium Labeling Facility (NTLF). Silica gel containing tritium was heated in a process kiln with an unfiltered but monitored exhaust, causing release of tritium oxide to the environment. Although this release was below the minimum reportable threshold, the incident was reported to DOE and a public press release was provided. Based on the wind condition at the time of the release, the calculated doses to the public MEI from this emission were extremely small (0.03 mrem). For conservatism, this unplanned release quantity was also included in this year total tritium emission and reflected in the reported MEI dose. Corrective actions were implemented in 1998 to prevent recurrence of this type of unplanned tritium emission.

Diffuse Emissions

In previous year, fugitive emissions from stored tritium waste in the old HWHF (Building 75A storage area) were measured and found to be less than 0.003 Ci (1.1×10^8 Bq) per year. Since all radioactive materials from this location were moved to the new HWHF at the end of 1997and all RMAs in this 75A facility have been decontaminated and decommissioned, this area is no longer considered in this assessment.

Section V. Supplemental Information

- *Provide an estimate of collective effective dose equivalent (person-rem/yr.) for 1998 releases.*

  The estimated collective effective dose equivalent (CEDE) to persons living within 80 km of Berkeley Lab is 2.52 person-rem/year (2.52E-2 person-Sv) attributable to 1998 Berkeley Lab airborne releases (see Table 23).

- *Provide information on the status of compliance with Subparts Q and T of 40 CFR Part 61 if applicable. Although exempt from Subpart H, provide information on Rn-220 emission from sources containing U-232 and Th-232 where emissions potentially can exceed 0.1 mrem/yr. (10^{-6} Sv/yr) to the public or 10% of the non-radon dose to the public. Provide information on non-disposal/non-storage sources of Rn-222 emissions where emissions potentially can exceed 0.1 mrem/yr. (10^{-6} Sv/yr) to the public or 10% of the non-radon dose to the public.*

  Subparts Q and T of 40 CFR 61 are not applicable to Berkeley Lab, as the Laboratory does not process, manage or possess significant enough quantities of uranium mill tailings, Ra-226, U-232, or Th-232, to produce an impact of 0.1 mrem/yr. (10^{-6} Sv/yr.) to a member of the public.

- *For the purpose of assessing facility compliance with the NESHAPs effluent monitoring requirements of Subpart H under Section 61.93(b), give the number of emission points subject to the continuous monitoring requirements, the number of these emission points that do not comply with the Section 61.93(b) requirements, and if possible, the cost for upgrades. Describe site periodic confirmatory measurement plans. Indicate the status of the QA program described by Appendix B, Method 114.*

  Berkeley Lab has identified 1 point subject to the continuous monitoring requirements of 40 CFR subpart H, Section 61.93(b). During 1998, only one point produced discharges exceeding 0.1 mrem/yr (1.0E-3 mSv/yr.). The Category I release point at Berkeley Lab was the NTLF main stack whose EDE was modeled at 0.27 mrem/yr (2.7 x 10^{-3} mSv) for 1998. Berkeley Lab has upgraded the monitoring and analytical methods to fully conform to Section 61.93(b) monitoring requirements. Berkeley Lab also: a) identified all emission points and evaluated releases, b) categorized stacks by EDE, and c) suggested suitable monitoring methodology for each point. The information developed in a - c above was sent to EPA region IX during CY91 and finalized in CY93.

  The program meets or exceeds all provisions contained in Appendix B method 114. The current Berkeley Lab Environmental Monitoring Plan and Environmental Protection Group Procedures contain QA elements consistent

with method 114. The Berkeley Lab site specific NESHAPs QA Project Plan was developed and approved in August 1994, and revised in March of 1997.